PCT 03/01420

#2

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

REC'D 04 JUN 2003
WIPO PCT

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

I also certify that the attached copy of the request for grant of a Patent (Form 1/77) bears an amendment, effected by this office, following a request by the applicant and agreed to by the Comptroller-General.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed Stephen Hordley

Dated 24 April 2003

Patents Form 1/77

Patents Act 1977
(Rule 16)

The Patent Office

THE PATENT OFFICE
C
-2 APR 2002
LONDON

1/77

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
Gwent NP10 8QQ

Your reference	P502747GB	
Patent application number *(The Patent Office will fill in)*	0207630.5	03APR02 E708084-3 C03090 P01/7700 0.00-0207630.5 -2 APR 2002
Full name, address and postcode of the or of each applicant *(underline all surnames)*	Paul Arthur Roland <u>MEYER</u> Galewood End Hinton Way Great Shelford Cambridge CB2 5AN	
Patents ADP number *(if you know it)*	1214477002	
If the applicant is a corporate body, give the country/state of its incorporation		
Title of the invention	Viewing Device	
Name of your agent *(if you have one)*	~~W.P.THOMPSON & CO.~~	
"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	~~Celcon House~~ ~~289-293 High Holborn~~ ~~London~~ ~~WC1V 7HU~~	Mewburn Ellis York House 23 Kingsway LONDON WC2B 6HP F51/77 1/4/03.
Patents ADP number *(if you know it)*	158007	

If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country	Priority application number *(if you know it)*	Date of filing *(Day/month/year)*
	--	--	--

If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application	Date of filing *(Day/month/year)*
	--	--

Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'yes' if: a) any applicant named in part 3 is not an inventor, or b) there is an inventor who is not named as an applicant, or c) any named applicant is a corporate body. See note (d))*	–	–

9.	Enter then number of sheets for any of the following items you are filing with this form. Do not count copies of the same document	
	Continuation sheets of this form	--
	Description	8
	Claims(s)	--
	Abstract	--
	Drawing(s)	4 + 4
10.	If you are also filing any of the following, state how many against each item.	
	Priority documents	--
	Translations of priority documents	--
	Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	--
	Request for preliminary examination and search *(Patents Form 9/77)*	--
	Request for substantive examination *(Patents Form 10/77)*	--
	Any other documents *(Please specify)*	--
11.		I/We request the grant of a patent on the basis of this application Signature Date W.P.THOMPSON & CO. 2 April 2002
12.	Name and daytime telephone number of person to contact in the United Kingdom	Dr. C.T. Eyles 020 7242 3524

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 01645 500505*
b) *Write your answers in capital letters using black ink or you may type them.*
c) *If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.*
d) *If you have answered 'Yes' Patents Form 7/77 will need to be filed.*
e) *Once you have filled in the form you must remember to sign and date it.*
f) *For details of the fee and ways to pay please contact the Patent Office.*

Viewing Device

This invention relates to viewing devices and is particularly directed to viewing devices capable of accommodation to allow focused viewing of objects at varying distances from the user of the device.

Although the human eye has some capacity for accommodation when viewing objects at varying distances from the eye, such accommodation becomes less effective with age. Various adaptations of spectacles are in use to address this problem, for example bifocal, multifocal or "varifocal" lenses. These approaches achieve clear focus only at particular viewing distances (usually at the near point and at infinity) and restrict the field of focused vision at each of them. Furthermore, they require the user to alter the elevation of his eyes in order to select a focal plane.

Since the natural deterioration of accommodation occurs in middle age, it interferes with every aspect of domestic, recreational and professional life to which a subject has become accustomed. For example, the preparation of a meal, reading music on a stand, undertaking machine work or viewing plans, all require an ability to focus any plane from nearby to infinity. A device that truly replicated visual accommodation would also enhance the quality of life among those individuals who lose accommodation in their youth for medical reasons.

According to the present invention, I provide a viewing device comprising a first lens having a concave surface within which nests a second lens having a convex surface and means for moving at least one of the lenses in a direction substantially normal to the facing concave and convex surfaces so as to create a cleft therebetween of changing width.

In one form of the invention, the material of the lenses and the medium within the cleft are selected so that the facing concave and convex surfaces each provide

refracting surfaces. In a further form of the invention, the lenses have the form of spherical light-transmitting plates separated by an oil of high refractive index within the cleft. Preferably the oil is of refractive index substantially the same as that of the plates.

Preferably the convex and concave surfaces are substantially spherical and preferably have the same radius of curvature so that, when they are brought into precise juxtaposition, the cleft between them is virtually eliminated. As the lenses are moved apart along their shared axis, the cleft between them is of changing width but uniform thickness for any one spaced separation.

The lenses may conveniently be plano-concave and plano-convex respectively. However it is anticipated that one or both of the outer lens surfaces may be contoured to deal with particular refractive errors of the user. The lenses may be constructed of any suitable light transmitting material including high refractive index plastics or glass. Their refractive indices may be the same or different. The lens surfaces may be coated to enhance transmission, or tinted, as is well known in the optical field.

In order to reduce aberrations, or lessen travel of the lenses, more than two nested lenses may be employed. They may have different refractive indices and define multiple clefts, which clefts may have width changing at substantially the same or different rates.

The means for moving the lens or lenses may be provided in any suitable way, for example by mounting the lenses in nesting cylindrical frames which slide or screw in relation to each other. If the cleft is filled with a fluid other than air, e.g. silicone oil, it will be necessary to provide leakproof sealing means to prevent egress of the fluid.

The device described above bases on the finding that, if a cleft is defined by

nesting concave and convex lenses, rays are diverged at the concave surface of the first lens, when the medium within the cleft is of refractive index less than that of the lens (e.g. air). The width of the cleft determines the angle of incidence at which the rays strike the convex surface of the second lens, this angle of incidence increasing as separation of the lenses increases. This determines the angle at which the rays exit the second lens and hence the position of the virtual image of the object plane. With increasing separation, the virtual image is displaced further away from the user.

It will be appreciated that, alternatively, the medium within the cleft may be of refractive index similar to or greater than that of the lenses, for example a fluid of high refractive index such as silicone oil.

The orientation of the lenses in relation to the user will depend on the medium within the cleft. If this medium is air, the device will, in use, be positioned so that the lens having a concave refracting surface facing the cleft is closer to the object being viewed.

In certain optical systems (e.g. for creating and moving real images) mirrors may be used for one or both of the spherical surfaces.

In one preferred form of the invention, the device comprises two pairs of first and second lenses intended to be worn as spectacles.

Therefore, according to this aspect of the invention, I provide a pair of spectacles comprising for each eye a viewing device as defined above. Preferably the moving means have a single actuating mechanism common for the pair of spectacles. This actuating mechanism may be mounted on the bridge of the spectacles and may, for example, have the form of a roller. Alternatively, autofocus mechanisms may be incorporated in the spectacles in accordance with known technology.

For spectacle wearers with normal vision but simply a problem of accommodation, it may be satisfactory for the outer surfaces of the lenses to be planar, especially in the situation where the medium within the cleft is of refractive index less than that of the lenses. However, those surfaces may be contoured for cosmetic purposes or to correct various visual defects as in conventional optical practice. When high refractive index oil is used as the medium within the cleft, the lenses may have curved outer surfaces or they may be replaced by spherical plates.

While the lenses will normally be positioned to give a cleft of constant thickness, one of the refracting surfaces may be tilted with respect to the other, for example for the correction of astigmatism.

The greater the change in refractive index at the main refracting surfaces, the more effective the system i.e. the same displacement of the image can be achieved with smaller separation of the surfaces. Thus the use of high refractive index materials, on either side of or within the cleft, may extend the usefulness of the invention.

If the internal refracting surfaces are spherical, but have unequal radii of curvature or refractive index, magnification (by means of a convex lens of shorter focal length or higher refractive index) or minification (by means of a convex lens of longer focal length or lower refractive index) is introduced into the variable focal length system. It has been found that, as long as both the internal refracting surfaces are spherical (regardless of their focal lengths), the system introduces little spherical aberration, giving images of high resolution.

The radii of curvature of the external surfaces affect the image in a manner which is predictable by conventional optics. Therefore the system can be computed using nested meniscus lenses. If the external surfaces are appropriately curved, additional refractive effects may be incorporated in the device, e.g. for correction

of myopia or hypermetropia with or without astigmatism.

In a special case of this principle, a positive contact lens is used as the second refractive element in the system. In front of this is placed a negative lens (meniscus or plano-concave) of short back focal length, with its concave surface facing the convexity of the cornea. Variable focus is achieved by moving this lens towards or away from the eye.

If the two internal surfaces are aspheric, either matched or unmatched, the system can introduce predictable aberrations (e.g. a fish eye effect for photography or displays).

If the weight or thickness of the lenses is too great for the desired application, it is contemplated that the lenses may be replaced by "spherical" Fresnel lenses formed of engraved concentric prisms.

The invention will now be described by way of example with reference to the accompanying drawings, wherein:
Fig. 1 is a diagrammatic representation illustrating the principle of the invention;
Figs. 2a and 2b are diagrams illustrating how an object can be brought into focus by separation of the lenses of the viewing device;
Figs. 3 and 4 are sketches, each showing a pair of spectacles in accordance with the invention.

Fig. 1 shows a device having a first planoconcave lens 2 and a second planoconvex lens 3, the concave surface 4 of lens 2 and the convex surface 5 of lens 3 being initially snugly nested together as shown in full lines. The surfaces 4 and 5 are substantially spherical and have the same radius of curvature. Thus, when snugly nested as shown in full lines, there is effectively no cleft between the lenses and the pair behaves as a single planar lens.

Means (not shown) are provided for displacement of lens 2 in a direction shown by arrow 6 to a position shown in dashed lines, or to any intermediate position between the dashed and full line positions. This defines a cleft 12 of changeable width but uniform thickness between the surfaces 4 and 5.

The lenses 2 and 3 are positioned in front of an eye, shown schematically by dotted lines 7. An object 8 is shown placed in front of lens 2. If the lens 2 is in the position shown in dashed lines, the rays from the object 8 will be refracted to diverge at surface 4 and will be again refracted to converge as they pass through surface 5, the extent of convergence depending on the angle of incidence, which becomes greater as the separation 6 of the surfaces increases. The image 9 of the object 8 will thus be seen at a plane which has been displaced in the direction of line 10 from the object 8. Dependent on the extent of the lens displacement indicated by arrow 6, this will bring the image 9 to a plane at or close to the near point focal plane 11 of the eye.

Fig. 2a shows a viewing device where the lenses 2 and 3 are in the position equivalent to that shown in full lines in Fig. 1. The ray diagram is shown for the viewing of a comparatively close object 8 by a presbyopic user who has a near point focal plane 11. Although the object is in a position suitably accommodated by a normal "youthful" eye, it is closer to the user's eye than the near point focal plane 11 of the eye, i.e. the presbyopic near point of that user. The object 8 will therefore be focussed to a plane behind the retina of the eye and cannot be brought correctly into focus by the user.

Fig. 2b shows the device where the lens 2 has been moved in direction 6 to a position shown in dashed lines. The refraction at facing internal surfaces 4 and 5 is now sufficient to move the focus of object 8 to a plane coincident with the retina of the eye. The image 9 is thus at or near the near point focal plane 11 for that user and the object is in focus for that user.

Figs. 3 and 4 each show a pair of spectacles in accordance with the invention. Each pair of spectacles comprises two viewing devices 20 linked by a nose bridge 21 and provided for wearing purposes with side arms 22. Each viewing device 20 has a first plano-concave lens and a second plano-convex lens as described below.

Fig. 3 shows one of the viewing devices 20 in exploded form. This has a first plano-concave lens 23 which has an internally threaded sleeved mount 24. The sleeve of this mount 24 threads over the threaded frame of a second plano-convex lens 25, so as to permit lens 23 to move towards and away from lens 25 to as to alter the spacing therebetween.

It will be appreciated that, in the absence of further actuating means, each lens 23 can be separately hand adjusted with respect to its associated lens 25. However, as shown in Fig. 3, common actuating means are provided. Thus, each lens 25 meshes with a gear wheel 26 and the two gear wheels share a common actuating roller 27 mounted on bridge 21, whereby the wearer can adjust the spacing of the two lenses simultaneously.

Fig. 4 shows an alternative form of actuating means. The pair of plano-concave lenses 23 are joined by a second bridge 28. Bridges 21 and 28 are linked by a roller mechanism shown schematically at 29. Each lens 23 carries at its outer side a slide 30, intended to engage a sleeve 31 within the side arm of the frame holding the convex lenses 25. Operation of roller 29 by the wearer allows movement of the lenses 23 towards and away from the lenses 25.

It will be seen from the above description that the device in accordance with the invention can find a wide variety of applications. These are contemplated as including:

- variable focus spectacles (including autofocus spectacles);
- existing spectacles can be made to have variable focus by clipping a pair

of matched concave or convex lenses to their inner or outer surfaces;

- spectacles for correction of aphakia, without the need for refraction and incorporating variable focus (this can be of value in less developed countries where the cost of implanting intraocular lenses is potentially prohibitive);
- variable focus contact lenses;
- intraocular lens implants with variable focus, to replace the natural lens after cataract extraction;
- provision of substantially aberration-free minifying spectacles with variable focus, allowing the titration of visual field against visual acuity (e.g. presenting a large field of vision onto a diminished area of innervated retina in a patient with glaucoma);
- provision of substantially aberration-free magnifying spectacles with variable focus in order to present an enlarged image of a reduced field of vision to diseased central retina;
- correction of astigmatism using paired spherical lenses with axes tilted with respect to the user's optical axis;
- provision of objectives or eyepieces for optical instruments such as binoculars, telescopes and microscopes;
- creating windows over displays (e.g. in cars or aircraft; instruments in laboratories or workshops; virtual reality displays) with the ability to move the image to a plane more suitable for viewing;
- camera lenses, especially variable focus macro lenses and zoom lenses;

When one or both of the refractive elements are mirrors, or with the addition of convergent lenses, the contemplated use can be extended to:

- projection systems;
- illumination systems;
- imaging systems.

Fig 1

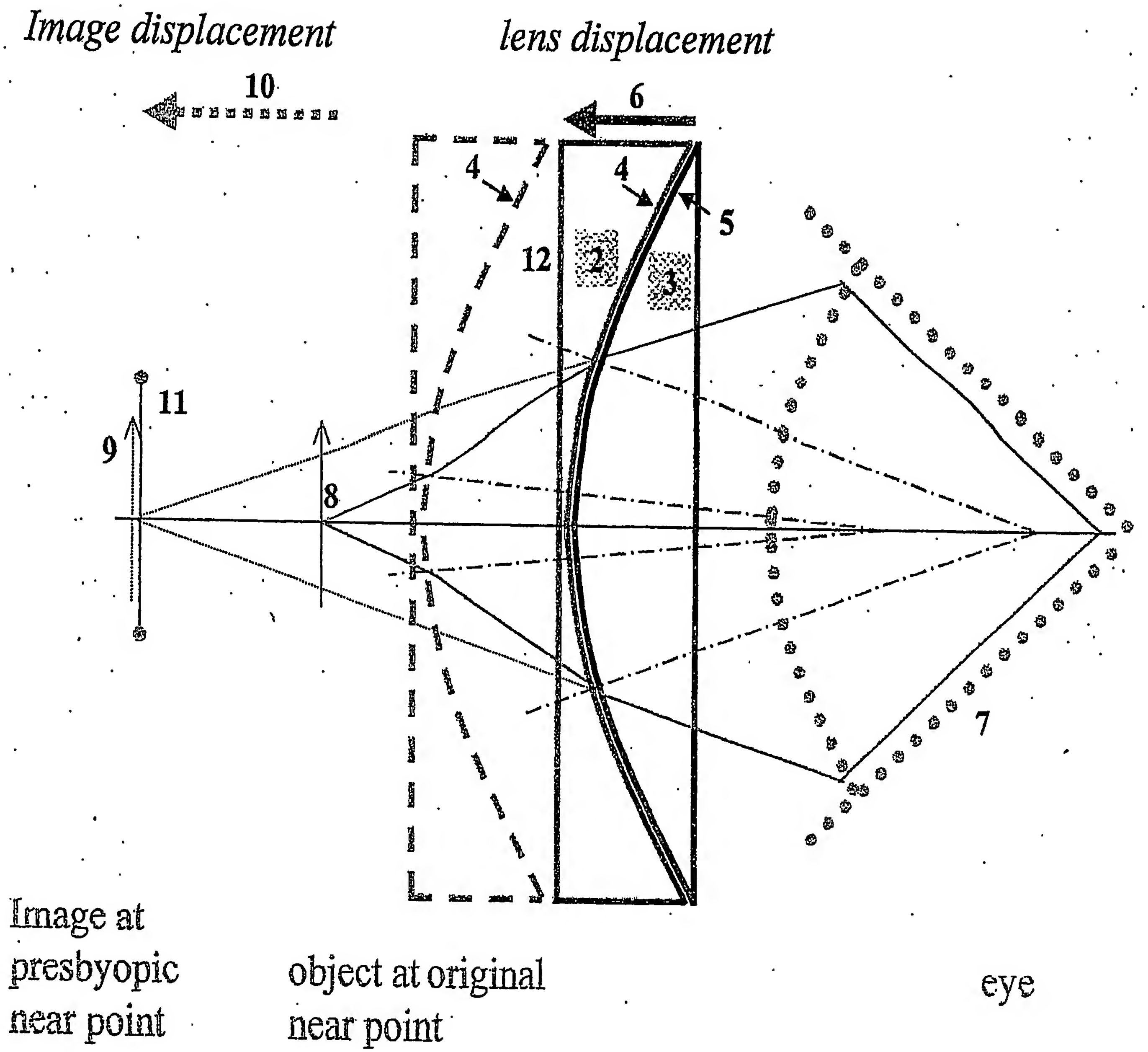
Image displacement
lens displacement
10
6
4
4
5
12
2
3
11
9
8
7
Image at
presbyopic
near point
object at original
near point
eye

Fig 2a

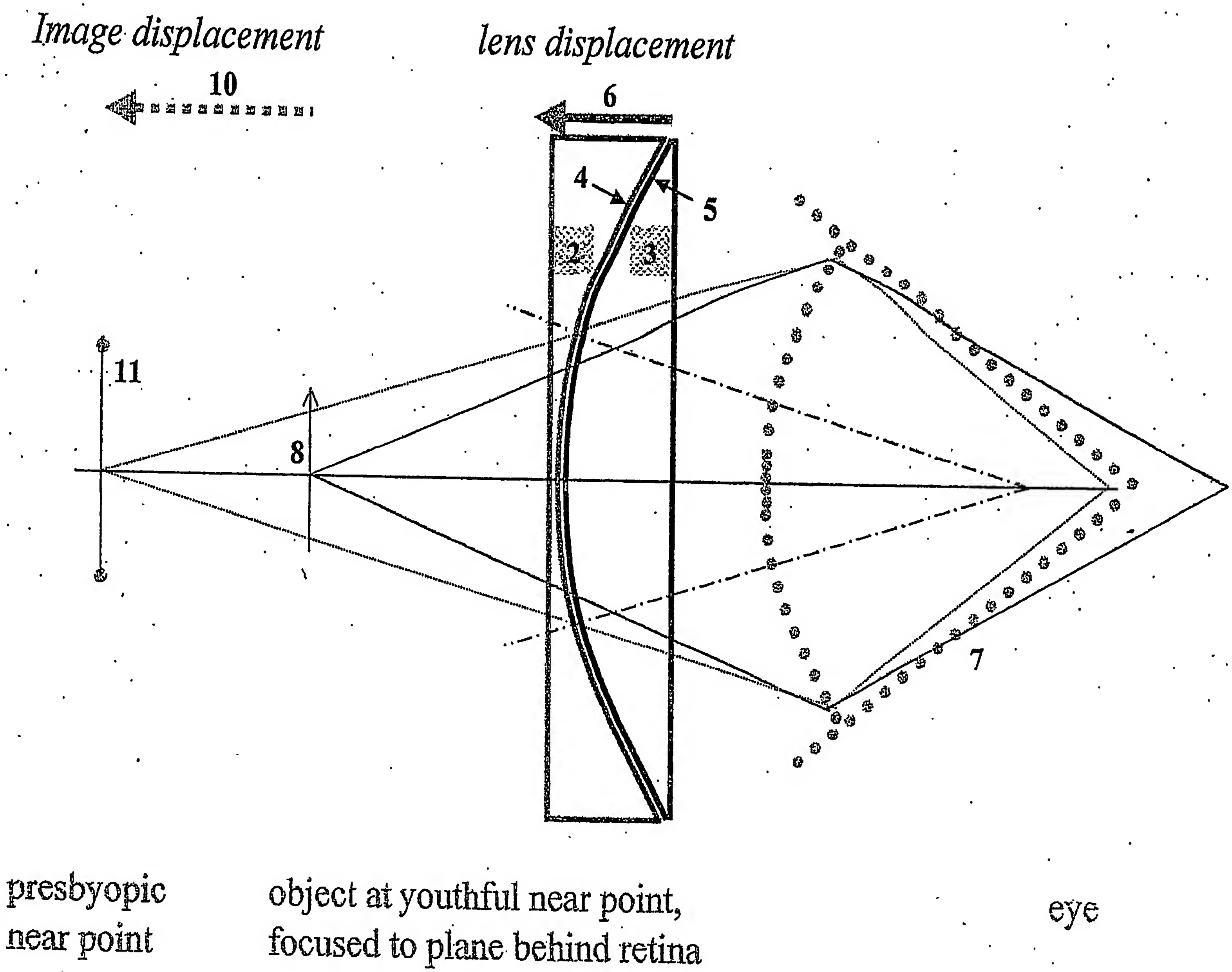
Image displacement
10
lens displacement
6
4
5
2
3
11
8
7
presbyopic
near point
object at youthful near point,
focused to plane behind retina
eye

Fig 2b

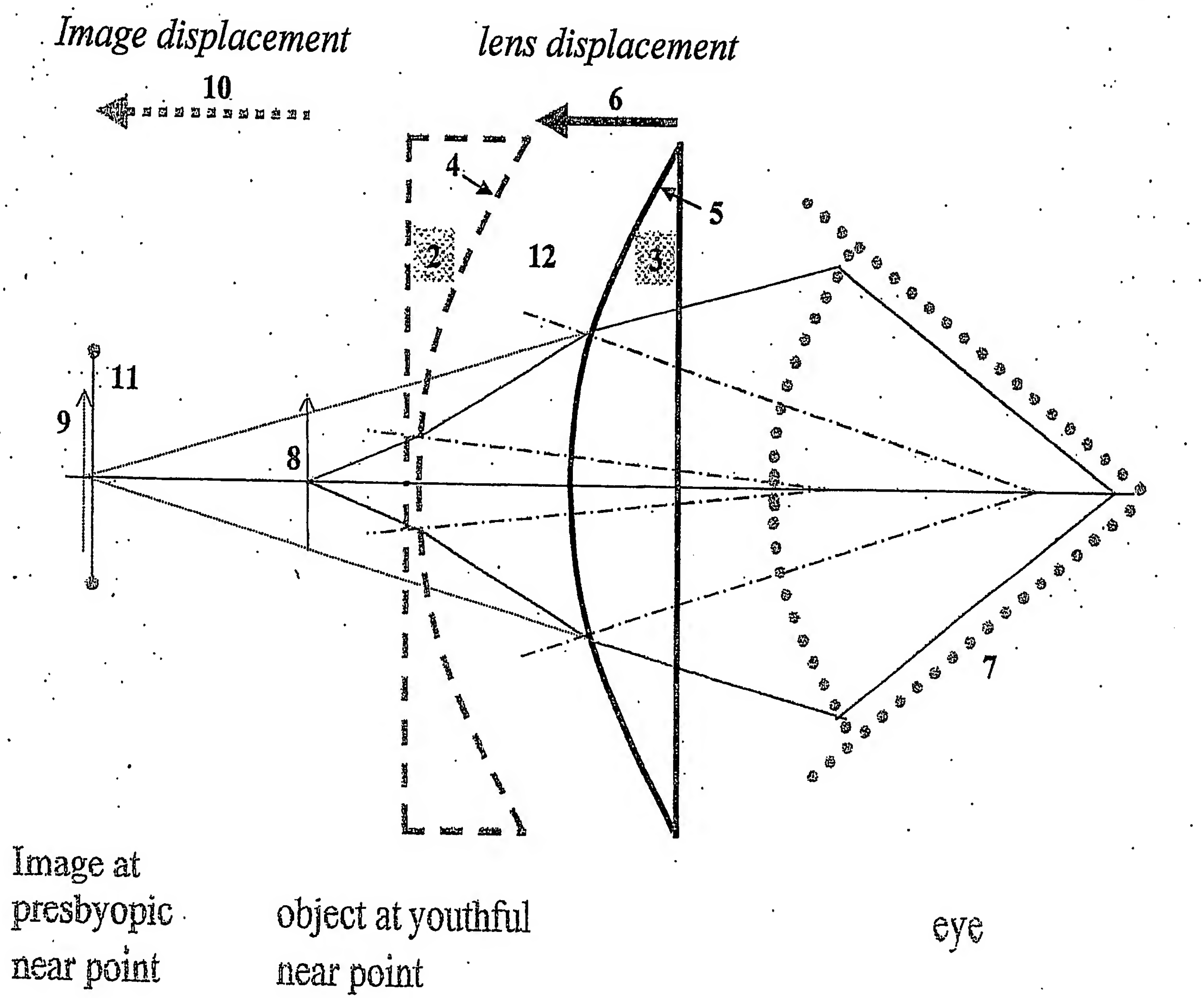
Image displacement
lens displacement
10
6
4
5
2
12
3
11
9
8
7
Image at
presbyopic
near point
object at youthful
near point
eye

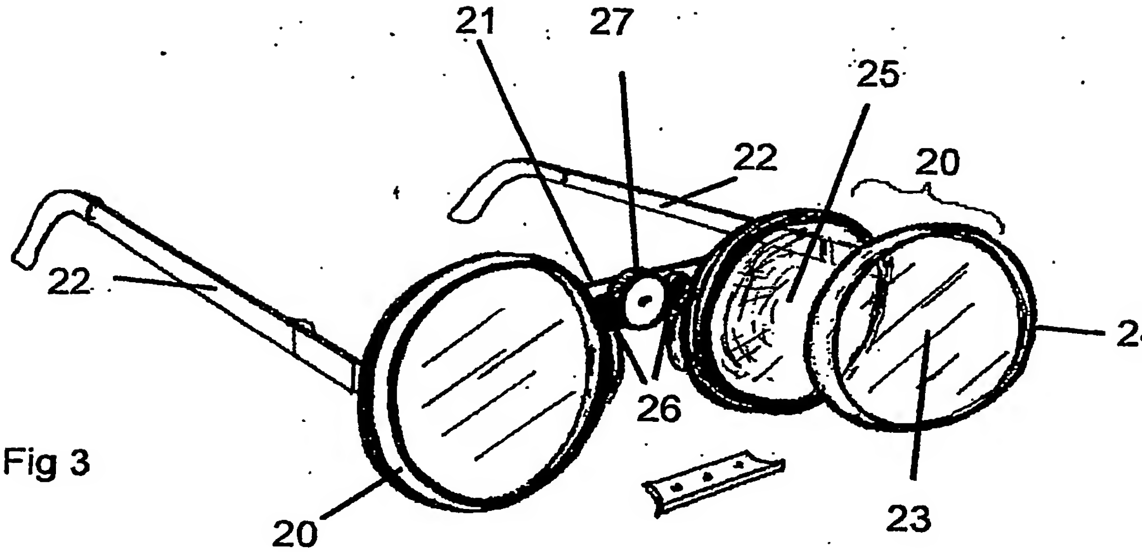

Fig 3

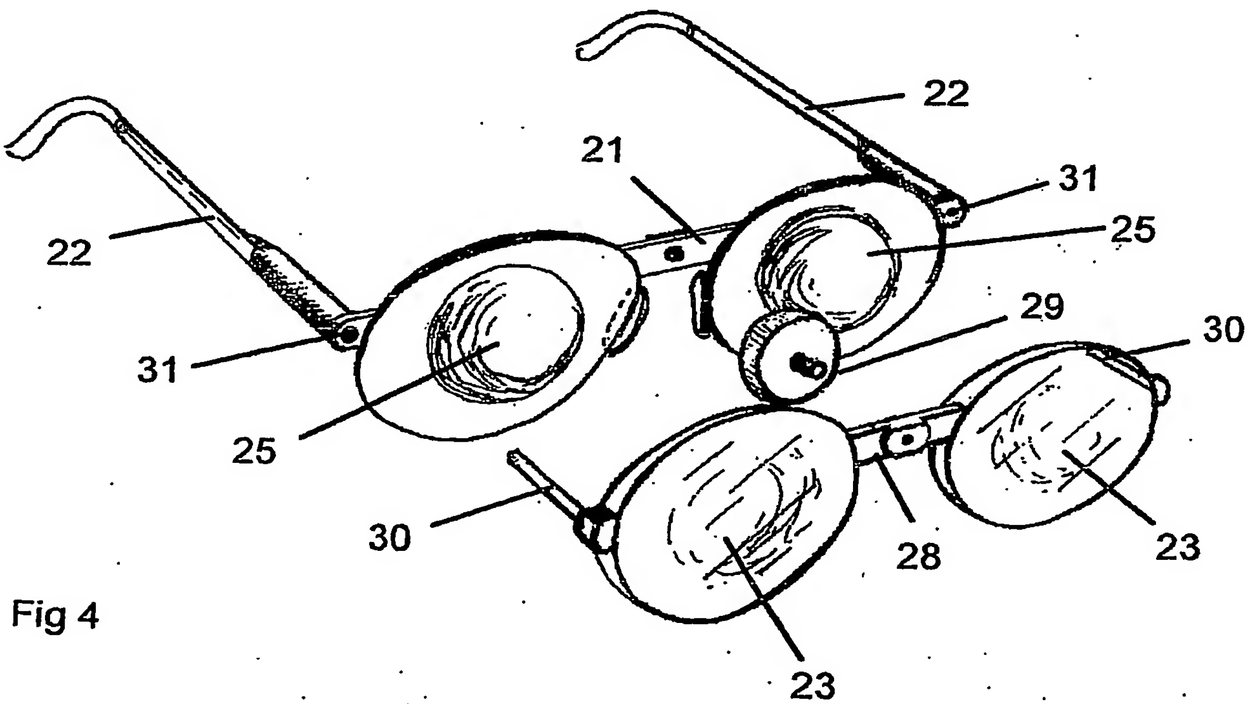

Fig 4